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MANUFACTURE OF COWS'-MILK ROQUEFORT CHEESE.

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Restricted importations of foreign cheese during the war period increased the price of these products and created a demand for information concerning their manufacture. Numerous attempts have been made to manufacture, in the United States, some varieties of foreign cheese, of which 63,000,000 pounds were imported by this country during 1914. Success has attended the making of some of these kinds of cheese; attempts to make others have resulted in absolute failure.

For several years the Dairy Division, Bureau of Animal Industry, conducted experimental work to develop a method of manufacture whereby at least one of the green-mold varieties of cheese, all of which bring high prices, could be made in the United States. As a result of the work this paper gives information on the manufacture of domestic Roquefort cheese from cows' milk, likewise some of the difficulties that may be encountered in manufacturing cows'-milk Roquefort cheese.

Roquefort is one of the highest-priced cheeses on the American market. It is a French mold-ripened cheese made from sheep's milk and has been known for 20 centuries. Pliny,[1] in his book on natural history, referred to this cheese, or cheese of this type, as

[1] Pline L'Ancien (Pliny the Elder). Histoire naturelle, Book XI, chapter 97 (42).

the "cheese most esteemed at Rome." Marcorelle[2] states that this cheese was used by peasants of France in their ceremonial repasts as long ago as 500 A. D.

There are two other varieties of mold-ripened cheese which are commercially important—the Gorgonzola, of Italy, and the Stilton, of England. Before the war Gorgonzola sold on American markets at practically the same price as Roquefort. Both Stilton and Gorgonzola are made from cows' milk. They are ripened with a mold similar to, if not identical with, that of the Roquefort and are skewered many times to allow air to gain access to the interior and thereby increase the development of the needful mold. The Gorgonzola, like Roquefort, is ripened in caves at a low temperature and is somewhat similar to Roquefort in flavor, texture, and composition, whereas the Stilton is a much drier cheese and is ripened with little or no refrigeration. While these cheeses resemble Roquefort in many respects, Roquefort is generally acknowledged to be the best of the three.

THE MANUFACTURE OF IMPORTED ROQUEFORT.

Almost the entire world's supply of Roquefort cheese comes from Aveyron, in southern France. The cheese is made principally of sheep's milk, although an admixture of cows' milk even there is acknowledged. All the milk used for this cheese is produced and made up into cheese within a radius of 50 miles of the small town of Roquefort, to which it is sent to be cured in the caves. There, too, are the headquarters of several firms that largely control the sale of the world's supply of this cheese. Sheep have been bred for centuries in the vicinity of Roquefort for making the cheese, and it is not uncommon for one sheep during a six-months' period of lactation to produce milk enough to make 35 or 45 pounds of cheese. In 1908 the milk from 450,000 of these sheep produced 19,845,000 pounds of cheese.[3] It is doubtful whether such a milking strain of sheep can be found in the United States, especially in sufficient numbers to warrant the establishment of a similar industry in this country.

The caves in Roquefort are of a peculiar rock formation in which there are caves and grottoes connected with one another and with the outside by numerous channels. Through these moist channels there is a vigorous circulation of air, causing a low temperature as a result of rapid evaporation. The temperature and humidity of the caves remain quite constant the year round, and these natural con-

[2] Art de faire le beurre et les meilleurs fromages. 1833. Anderson, J., and others.

[3] Lebrou, P., Les applications du froid en Aveyron à la préparation des fromages de Roquefort. Pp. 424, II. In 2d Internat. Cong. Refrig. Industries, Vienna, 1910.

ditions, together with the ventilation, are favorable to mold growth and to the ripening of Roquefort cheese. At Grove City, Pa., insulated curing rooms have been constructed which are provided with certain conditioning apparatus and refrigeration which make it possible to approximate the conditions found in the caves of Roquefort. As the ideal conditions for making this cheese have been approached, many of the discouraging aspects of the problem have been eliminated. Prevention of desiccation, oversalting and undersalting, proper growth of interior and exterior molds, proper flavor and texture, all appear to be more or less dependent upon supplying and regulating the proper curing conditions. By the use of such equipment considerable cows'-milk Roquefort cheese of good quality has been made and successfully marketed.

COMPOSITION AND CHARACTERISTICS OF ROQUEFORT.

The literature shows a great variation in the composition of Roquefort cheese. The composition as given by Duclaux is in accord with that of Dox, formerly of the Dairy Division.

TABLE 1.—*Total composition of an excellent Roquefort cheese, according to Duclaux.*[1]

Substance.	Quantity.
	Per cent.
Casein	20.00
Fat	35.18
Salt (NaCl)	4.21
Other mineral salts	1.77
Water	38.84

[1] Maturation des fromages à basse température, 1901.

TABLE 2.—*Average composition of ripe Roquefort, with respect to fat, water, and salt.*

Substance.	Quantity.
	Per cent.
Fat	20 to 36
Water	38.5 to 41.
Salt (NaCl)	3.5 to 4.5.

Several samples of Roquefort cheese of the highest quality were selected and analyzed by Dox.[4] The composition was as follows:

TABLE 3.—*Composition of highest quality Roquefort cheese.*

	Water.	Fat.	Protein.	Ash.	Salt (NaCl).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Average	38.69	32.21	21.39	6.14	4.14
Minimum	37.49	31.50	19.14	5.18	3.64
Maximum	40.10	33.53	23.06	6.81	4.88

[4] Dox, A. W., Die Zusammensetzung des echten Roquefort-Käses. In Ztschr. f. Untersuchung. Nahr. u. Genussmtl., v. 22, no. 4, pp. 239-242. 1911.

There is a remarkable uniformity of composition in the best grades of this cheese. Good Roquefort should contain close to 40 per cent water, 4 per cent salt, and 32 per cent fat. Special significance is attached to the salt-and-water content of the cheese, and the composition of the domestic cheese has been made to approximate as closely as possible that of the imported cheese.

Size.—Roquefort cheese is round, about 7 inches in diameter, and 4½ inches high. Such a cheese should weigh from 4 to 5 pounds.

Surfaces.—There is no definite rind on the ripe Roquefort cheese. The softening of the cheese is due to the mold enzyms and to inclosing it in tin foil, which tends to make the texture of the cheese uniform throughout. As the cheese on the market is wrapped in foil it always appears to be moist, rather than either wet or dry. The surface of the cheese is more or less uneven as a result of punching and scraping.

Odor and color of surface.—The odor of the cheese is not likely to be offensive unless it is too wet or has been kept too long at a high temperature. The color should be slightly orange and never dark.

Mold.—The most conspicuous characteristic of a cut Roquefort cheese is the green mold. This and the *Streptococcus lacticus* have been found to be the chief ripening agents of the cheese.[5] The cheese presents a marblelike appearance of green and white with luxuriant patches of the mold here and there, but more especially near the mechanical holes which occur more often near the center than near the outer edge. Radiating and ramifying veins of mold extend from the central portion of the cheese to within an inch or so of the outer edge, where there is little or no mold development. Possibly this is due to a higher concentration of salt near the outer edge during the period of mold growth, resulting in a dryer layer as compared with the interior. Ordinarily the mold is bright in color, but where the ripening has been carried to an advanced stage it takes on a darker hue. This is especially true when the mold is subjected to a vigorous oxidation. The mold in the trail of the piercing needle is often of a darker color than that in the cheese a short distance from this point, where the air can not penetrate so readily. The color of the mold in a freshly cut domestic Roquefort cheese which has been held at a low temperature for a long period may have nearly disappeared. In the course of a few minutes, however, upon exposure to the air, the normal green color of the mold gradually returns.

Saltiness.—The saltiness of Roquefort cheese is quite characteristic and is more noticeable when the cheese is fresh than when the flavor has been fully developed. It is the most salty soft cheese on

[5] Evans, Alice C., Bacterial flora of Roquefort cheese. In Jour. Agr. Research, p. 232. (Vol. XIII, No. 4. Apr. 22, 1918.)

the market. To many this quality is not pleasant, and yet it is doubtful whether Roquefort cheese can be successfully ripened without a high percentage of salt in it. Other conditions being the same, the higher the percentage of salt the slower the ripening, and vice versa.

Defects.—The most common defects of Roquefort cheese made from cows' milk are: The high moisture content, too little or too much salt, the lack of mold, the lack of piquancy, and a color which is too yellow. Cheese is not likely to become waxy and tough unless it has been subjected to excessive ventilation and to too low a relative humidity. Cheese which is gassy sometimes develops offensive flavors, possibly due to an excessive oxidation of the fat. Roquefort is quite soft as compared with other cheeses, and as a result the surfaces and edges are quite easily broken by handling during the curing process.

One of the essential qualities of a Roquefort cheese is that the color be white rather than yellow. The natural color of sheep's milk is white rather than yellow. Marre speaks of it as having "a fine white color." [6] "The cheese is too yellow" has been the most common criticism of cows'-milk Roquefort.

Because of cheaper milk the cows'-milk Roquefort cheese upon which the data in the bulletin are largely based was made during the months of June and July, rather than in the winter months, when the natural color of the milk is more white. In the experimental work at Grove City more attention has been given to the considerations of flavor, mold, salting, etc., and less attention to color, which seemed of minor importance. Experience in marketing, however, has shown that color is of much greater importance than had been anticipated.

From chemical analysis there is reason to believe that not a great deal of fat is removed in the manufacture of Roquefort, although authorities agree that some of the fat is removed. Marre, in this connection, states that the sheep's milk should preferably be partially skimmed, and that unless this operation is carried to the extreme the quality of the cheese is not appreciably impaired, while the drainage of the curd is favored. Without this procedure the cheese, which should be white and light, will be yellowish, compact, and dense as glue.[7] On the other hand, a milk skimmed too much gives a dry curd, without adherence and without flavor.

Flavor.—A salty and piquant flavor is the chief characteristic of this cheese and allied blue-mold cheeses of this group. A good cheese should be sapid, sweet, and fragrant. A Roquefort cheese should not have a strong, pungent flavor. This condition may

[6] Marre, E., Le Roquefort, p. 80.

[7] Marre, E., Le Roquefort, p. 95.

develop when the cheese has been subjected to long exposure to the air or when held at too high a temperature. In general, the lighter the color of the mold the milder the flavor of the cheese.

Texture.—Roquefort cheese should not be compact, like Cheddar cheese. Numerous mechanical holes should be made throughout the cheese. A few gas holes may not be harmful, but too many should be avoided. Even the best of the imported cheeses almost always have a number of small gas holes. The mass of the cheese should be friable, soft, and unctuous; yet it should be firm enough to retain its shape, even when held at a high temperature. The cheese when fully ripe should not appear tough and waxy, as in the case of certain other green-mold cheeses.

COMPOSITION OF SHEEP'S MILK.

The percentage composition of sheep's milk in the Roquefort region, as given by Marre,[8] is quite different from that of cows' milk.

TABLE 4.—*Per cent composition of sheep's milk in the Roquefort region.*

	Water.	Casein.	Fat.	Lactose.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Variation	76 to 83	5 to 8	5.5 to 10.5	4 to 5	0.8 to 1.2
Average	79.5	6.5	8.0	4.5	1.0

Work with sheep's milk has revealed the fact that the acidity of the fresh milk when titrated with phenolphthalein is usually more than 0.2 of 1 per cent, and in contrast with cows' milk gives a much firmer jellylike curd when acted upon by rennet. An examination of the composition of sheep's milk and cows' milk shows that the former has about twice the essential solids of fat and casein that the latter has, yet the ratio of fat to casein in both cases is approximately the same. Rich milk seems somewhat more desirable than poor milk in giving a firm curd when it is set with rennet. Milk testing about 4 per cent has given good results.

THE MANUFACTURE OF COWS'-MILK ROQUEFORT.

In general it has been found to be advantageous to follow the method of making this cheese as outlined by Marre. Because of the difference in the nature of cows' milk and sheep's milk, however, some modification of the process seems advisable.

Acidity.—Fresh, clean milk is essential in making Roquefort. An overripe milk is likely to result in a gassy cheese and may produce a very objectionable flavor. The milk on setting should have an initial acidity of 0.21 to 0.23 per cent. About 3 or 4 per cent of starter is

[8] Marre, E., Le Roquefort, p. 82.

recommended. Sometimes it may be desirable to add the starter to the milk and then ripen the milk to the desired point. There is no indication in the literature that a starter is used in the making of the sheep's-milk cheese. Small variations in the acidity will not cause disastrous results.

Temperature.—Marre advises a temperature of from 24° to 28° C. (76° to 82.4° F.) for setting sheep's milk. For the making of cows'-milk Roquefort a temperature of from 82° to 85° F. is the most desirable. With cows' milk a lower temperature is likely to result in a soft and mushy curd which fails to drain properly. Too high a temperature may make a tough curd.

Setting and rennet.—The milk is warmed in an ordinary 5,000-pound Cheddar-cheese vat and then is stirred to insure an even distribution of the fat. Standardized commercial rennet has been used always with good results. On a basis of 1,000 pounds of milk 3 or 4 ounces (90 to 120 c. c.) of rennet are used. The use of too little rennet may result in an incomplete coagulation, with excessive losses of both fat and casein in the whey. As is customary in making other kinds of cheese, the rennet should be diluted in cold water before it is added to the milk, after which the whole should be carefully stirred.

Cutting.—According to the French method the cheese is cut into lozenges about the size of a walnut and after standing for 10 minutes the curd is removed by means of a scoop and emptied upon the drain cloths. In making the cows'-milk cheese the curd is cut both ways by means of a $\frac{5}{8}$-inch Cheddar knife. As the curd is being transferred to the drain cloths by tin scoops it is cut crosswise so that the resulting pieces are five-eighths of an inch square by 2 or 3 inches long. If the curd is cut into larger pieces it is more easily broken and, besides, does not expel the whey so readily. Differences in the natural firmness of the curd of the sheep and that of the cow seem to make this change advisable.

Curdling time.—The setting period varies from 1 to $1\frac{1}{2}$ hours, according to the acidity, temperature, and quality of the milk. At first beads of whey, then a thin film of whey, gradually spreads over the surface of the curd, indicating that it is ready to cut. By this time the curd gradually contracts and tends to draw away from the side of the vat. At this period the coagulum should be firm and porcelainlike and should cut readily under the edge of the knife. When the curd has set too long, it is not so readily cut, but pushes along ahead of the knife. There should be no contraction of the curd or unevenness anywhere upon the surface, aside from where it is in contact with the vat. No hard and fast rule can be laid down as to the time of cutting, as so much depends upon the condition of the milk, temperature, and acidity.

Draining the curd.—An adjoining Cheddar-cheese vat of capacity similar to that of the setting vat has been found an excellent substitute for a draining wagon. A skeleton framework is placed in the bottom of the vat and covered with strong cheesecloth. The setting and draining vats should be placed close enough together to permit two or three workers to do the dipping. Large tin scoops holding 1 or 2 gallons each are suitable for this purpose.

The transferring of the curd should be done rapidly and carefully, and two persons working rapidly should dip 3,000 pounds of milk in from 25 to 30 minutes. The whey should be withdrawn from the vat and run through a whey separator. In draining the curd it has been found helpful to raise the cloths from time to time in order to aid the exudation of whey and to bring the curd to the proper condition of dryness. In making the French cheese much emphasis is placed on keeping the curd warm and holding it at an even temperature, and for this reason the curd is frequently turned by means of a short-handled ladle. No difficulty has been encountered at Grove City from having the curd become too cold.

Fat losses.—Fat losses in experimental work have averaged from 0.2 to 0.3 per cent. On a larger scale the fat losses almost always are below 0.3 per cent.

Time of draining.—The time required for draining is ordinarily from 20 to 30 minutes, depending upon how often the cloths are manipulated during drainage. The curd should be placed in the forms in a fairly moist condition. When the curd is too dry, the surface of the cheese is not smooth and compact and may offer an avenue whereby undesirable organisms may gain access to the interior of the cheese. When the surface of the cheese is not smooth, greater losses are sure to occur later in the curing process. Results from many experiments indicate that there is no advantage or disadvantage in using a longer or a shorter period for drainage.

Hoops.—The hoops or forms for cows'-milk Roquefort are round, open, and are $7\frac{3}{8}$ inches in diameter and 6 inches high. Each hoop has six rows of holes running around the form and there are twenty-five $\frac{1}{8}$-inch holes in each row. The hoops are considerably higher than the cheese itself. The forms are made of galvanized metal with wired edges.

Forms are placed conveniently close to one another upon a special reed matting. The size of the mats is 10 by 34 inches and they rest upon boards of nearly the same size. With mats of this size three cheeses are needed to fill one board. Cloths may be substituted for matting, although the matting is preferable. Before using, all mats as well as boards should be placed in a vat of boiling water. This procedure tends to reduce the number of foreign molds which may cause losses later in the curing process.

FILLING THE FORMS AND ADDING THE MOLD CULTURE.

At the time the curd is put into the forms it is a white, pulpy mass, from which but little whey exudes as the forms are filled. Alternate layers of curd and of mold powder are put into the forms. The mold powder, which will presently be discussed, is sprinkled liberally over the layers of curd by means of a pepperbox. Usually three or four layers of powder should be used in each cheese. The curd is broken up by hand into small pieces, and it is then placed in the forms and gently pressed. The curd is piled above the top of the form. This gradually settles down so that by the time the cheese is ready to salt it is about 4½ inches high. There appears to be no distinct advantage in using a large quantity of mold powder. Experiments have shown that 0.2 of a gram of mold per cheese gives almost as good

FIG. 1.—Filling the forms with curd and inoculating with the mold.

results as 2 grams of the mold. However, four or five liberal sprinklings of the mold are desirable.

Wooden supports, about 2 by 4 inches are placed across the vat about 30 inches apart. A board, covered with a mat, and three forms are placed upon these supports. As the forms are filled, the boards supporting them are transferred to a hand truck which is used to carry the cheese to the drain room.

PREPARATION OF MOLD POWDER FOR INOCULATION.

Mold powder for inoculating purposes is grown in ordinary white bread. Stock cultures of Roquefort mold should be obtained from a reliable laboratory several weeks before the manufacture of the cheese is contemplated. The mold powder is prepared as follows: Either fresh bread, direct from the oven, or older bread, is sterilized

in a dry oven for two hours at 170° C. (338° F.). In either case the bread should be allowed to cool before it is inoculated with the mold. Freshly baked bread is preferable, for it contains more moisture. When the bread is dry-sterilized it may be improved by putting it into a steam sterilizer for a time in order that the bread may regain some of the moisture lost in the dry-sterilizing process. By means of a sterile platinum needle Roquefort-mold spores from an agar culture are transferred to a flask of sterile water. The mixture is then shaken and a portion of it drawn off by means of a sterile pipette. The point of the pipette is thrust into the bread in several places and a small quantity of the liquid allowed to run into the bread in each case. When the pipettes are small several are used for each loaf of bread. It is not advisable to use the pipette twice for inoculating the bread. At least an ounce of the water culture should be used for each loaf; too little moisture will result in a meager growth of mold and a great part of the bread will be wasted. The holes made by the pipette may be covered with a gummed label, and it is advisable to cover the inoculated bread with a thin coating of hot paraffin. The inoculated bread should be put into a moist, cold place (about 50° F.) for several weeks to allow the mold to develop to a stage at which it may be used in the cheese. When grown at a temperature of from 50° to 52° F., it takes two or three weeks for the mold to grow to a stage where it is fit to be made into powder. This condition is indicated by the spreading of the colored mold throughout the bread.

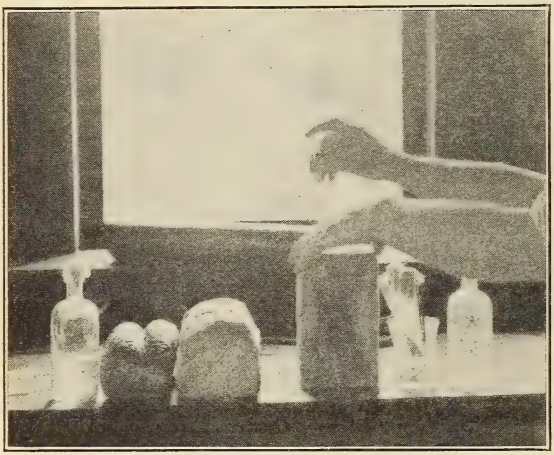

FIG. 2.—Inoculating the bread with pure culture of Roquefort mold.

Foreign molds are more likely to cause trouble at a high temperature, and the desired mold appears to make a more vigorous development in the cheese when grown at a low temperature. In some instances in which we have grown the mold at a high temperature (room temperature) and held it for a time before using it, the mold has failed to develop properly, or at least luxuriantly, in the cheese. When there is evidence of foreign mold in the bread either

the infected part should be removed or the entire loaf should be discarded. Although their presence may not be indicated, by spores of another color, under the best conditions there will probably be some foreign molds present. By virtue of the power of Roquefort mold to grow rapidly at a low temperature and in the presence of a high percentage of carbon dioxide in the cheese,[9] foreign molds appear to cause but little trouble in the cheese. This is especially true when the mold is grown in bread at a temperature of 50° F.

When the mold is thoroughly dry the bread is sliced and ground up by means of a coffee grinder or a mortar and pestle. The mold powder should be kept in a cold, dry place; otherwise there is a tendency for the bread to reabsorb moisture and cause the mold powder to spoil. Usually the bread is ground as fine as pepper. When the bread is cut before drying it is green, and upon drying it assumes a darker hue. The mold will keep for several months in a cold, dry place.

The French process for making the bread for mold development requires 2 parts of wheat flour, 1 part of rye flour, and a great deal of yeast. The bread is acidified by vinegar to prevent the development of foreign bacteria, and then baked. After the mold has grown in the bread at a temperature of 53° F. and at a relative humidity of 88° the bread is dried at 90° F. and made into a fine powder. When growing the mold we have observed no special advantage in using vinegar, especially if the mold is grown at a low temperature, or in making the bread from combined flours.

Another method of mold development suggested by Chavastelon[10] has given good results. The bread is first sterilized, then broken up into pieces about one-half inch in diameter, and soaked in a 3.5 to 3.7 per cent solution of tartaric acid. The pieces of bread rest on a wicker mat which has been sterilized. This arrangement permits a circulation of air. A high humidity and relatively low temperature are maintained and the crumbs of bread are turned once or twice during the period of mold development. By this method the bread becomes more thoroughly molded and there is less unmolded bread than when the mold is introduced into the interior of the loaf. There is a greater chance for surface contamination, however, although there is a smaller loss from unmolded bread.

Handling during draining period.—When loaded with the cheese, the truck is run into the drain room. The temperature of this room should be from 65° to 68° F., and the air moist enough to prevent the cheese from drying out (85° to 90° relative humidity). A continu-

[9] Thom, C., and Currie, J. N., The dominance of Roquefort mold in cheese, Journal of Biological Chemistry, Vol. XV (1913), No. 2, pp. 247–258.

[10] Chavastelon, M. R. Sur la culture practique de la moisissure verte (*Penicillium glaucum*) pour la fabrication des fromages bleus. In Compt. Rend. Acad. Agr., France, 1918, v. 4, no. 18, pp. 564–566.

ous high temperature for draining favors rapid development of the *Oidium lactis* and other destructive microorganisms. Excessive losses as well as an impaired quality of the cheese result from an overdevelopment of these forms of life. An air too dry causes the surface of the cheese to become yellow, hard, and dry. This condition is undesirable because the cheese fails later to absorb the salt properly and great losses are likely to occur in the scraping process. This condition is more likely to arise when there are only a few rather than a large number of cheeses in the drain room. When this room is filled with cheese, continuous ventilation seems desirable in checking somewhat the destructive action of *Oidium lactis*. Fifteen or twenty minutes after the forms are filled they should be turned. In turning, one hand raises the cheese from the surface of the mat while the other hand is slipped beneath the cheese and both the form and cheese are quickly reversed. The cheeses should be turned several times during the first day and twice a day thereafter until ready for salting. The object of the repeated turning is to hasten drainage and to insure an even, smooth surface.

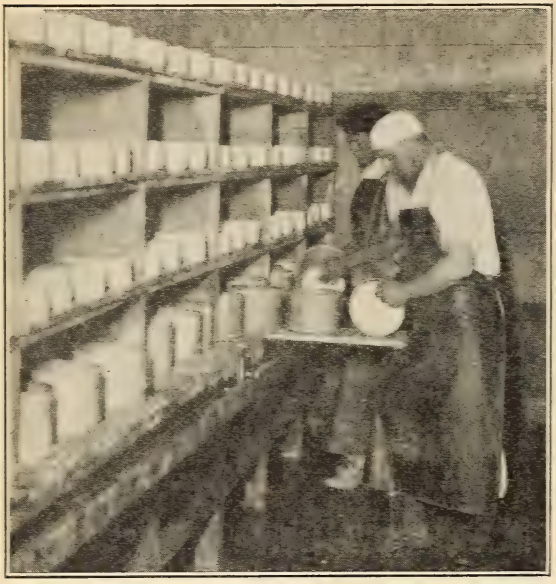

FIG. 3.—Turning the cheese during the draining period.

Forms are allowed to remain on the cheese for the first two days and then are removed and washed. The French practice calls for washing both the cheese and forms night and morning, using cold water in summer and warm water in winter. In the work at Grove City the cheese and boards are washed only in the morning. The mats are removed the day after the cheese is made and thereafter the cheese rests directly on the boards. The cheeses are allowed to drain for four or five days, until little whey escapes from day to day. Much of the success in making this cheese depends upon having the cheese dry enough before the salting period.

TABLE 5.—*Water content of cheese one day after making; drained at 68° F.*[1]

Sample.	Water.
	Per cent.
No. 1	50. 78
No. 2	51. 79
No. 3	49. 68
Average	50. 78

[1] The chemical determinations from which Tables 5, 8, and 9 are derived were made by E. H. Parfitt.

A cheese 1 day old should contain about 50 per cent water.

Table 6 shows the daily losses in weight of 67 cheeses held at a temperature of from 70° to 75° F.

TABLE 6.—*Showing daily loss in weight of cheese during the draining period.*

	First day.	Second day.	Third day.	Fourth day.	Fifth day.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Total weight	549. 70	506. 5	370. 93	363. 9	357. 93
Average weight per cheese	8. 05	7. 59	5. 53	5. 41	5. 34

Table 7 shows the daily loss through drainage and indicates that there is not a great loss in weight after the first few days in the drainage process.

TABLE 7.—*Loss in weight of two lots of cheese during the draining period.*

	First day, temperature 74.3° F.	Second day, temperature 68° F.	Third day, temperature 68° F.	Fourth day, temperature 64.4° F.	Fifth day, temperature 69.8° F.	Sixth day, temperature 68° F.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Total weight	96. 97	63. 53	60. 68	58. 54	57. 11	56. 22
Average weight per cheese	8. 81	5. 77	5. 51	5. 32	5. 19	5. 11

TABLE 8.—*Water content of cheese at time of salting.*

Sample No.	Water content.
	Per cent.
1	45. 50
2	45. 08
3	45. 20
4	45. 70
5	44. 60
Average	45. 21

Water determinations were made on the samples above after they had drained and were ready for the salting process. These samples were taken from the cheeses recorded in Table 6, which were

held under a uniform temperature in the draining process. At the time of salting a cheese should contain about 45 per cent water.

Salting.—Roquefort cheese is salted on the outside at a temperature of approximately 48° F. and in a dry room. It should be salted the fourth or fifth day after making. During this period it is desirable to have some ventilation to remove the excess moisture occasioned by the salting. The entire salting process should require about 10 days. At the time of salting the cheese should be moist but not wet nor yellow. Having the cheese too dry may result in undersalting. The cheeses are carried on a hand truck to the salting room and eight cheeses are piled on each board. In order that the cheeses may acquire the same temperature as the salting room they should be left there overnight.

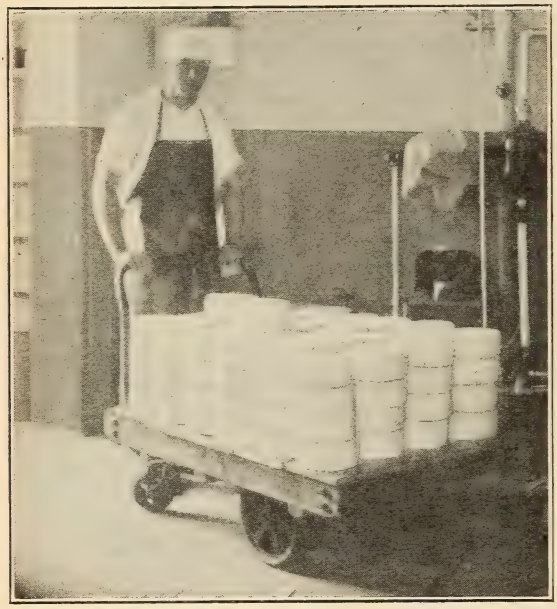

FIG. 4.—Transferring the cheese from the draining room to the curing room.

Fine, dry salt then is rubbed vigorously over the surface of the cheese, and all the salt that will adhere to the cheese is used. The salt permeates the cheese and tends to remove the excess whey. After the cheeses are salted they are put in piles of two or three, and the following day their position is reversed, with no addition of salt. On the third or fourth day they are again salted in the manner previously described.

After an intervening day the cheese is sprinkled over very lightly. Some experience is required before a person can salt Roquefort cheese successfully, and this work must be very carefully done. Some system of piling or marking should be used in order that one may tell at a glance the stage of salting. Unless great care is taken there is always a tendency either to undersalt or to oversalt. Undersalting is the greater evil. As previously noted in the analyses of Roquefort cheese each cheese should contain approximately 4 per cent salt and 40 per cent moisture. Since salt amounting to about 10 per cent of the weight of the cheese is used, there is a loss in drain-

age of about 6 per cent. This high salting, as compared with the salt used for other cheese, is sufficient to prevent an excessive development of *Oidium lactis*. The practical elimination of this organism is essential.

While a higher temperature and a shorter draining period have sometimes been used in salting the cheese,[11] it is believed that by using a temperature of 48° to 50° F., similar to that in the French practice, it is possible to salt the cheese more uniformly and with less danger of oversalting. Some manufacturers are now salting the cheese a day or so after making; but although this method has been successful in some cases, there is danger of oversalting.

FIG. 5.—Salting the cheese. Fine, dry salt is rubbed vigorously over the surface of the cheese, and all the salt that will adhere is used.

Salting by immersing the cheese in brine has not been successful, for when this method is used a rind forms and the cheese often cracks, as a result of the intense contraction of the surface in the expelling of whey. The object of a low temperature for salting is to reduce losses and favor the development of the desirable forms of mold.

TABLE 9.—*Water and salt content of cheese after salting.*[1]

Sample No.	Water.	Salt.
	Per cent.	*Per cent.*
1	42.45	4.61
2	41.65	4.70
3	41.60	4.72
4	42.45	4.48
5	41.95	4.53
6	41.40	5.28
Average	41.91	4.72

[1] The temperature at time of salting was from 46.6° to 48.2° F.

The salt in the samples (Table 9) is a trifle high. As it requires about three weeks before the salt reaches an equilibrium in all parts

[11] Bulletin No. 79, Storrs Experiment Station, Storrs, Conn. Studies relating to the Roquefort and Camembert types of cheese, Charles Thom, J. N. Currie, and K. J. Matheson.

of the cheese, it is likely that the salt percentage would be slightly lowered by subsequent scrapings. Some of the water, possibly 1 or 2 per cent, will be lost in ripening before the cheese is enveloped in foil.

First scraping.—After a week or so in the draining room the cheeses are given their first scraping. This is done with knife or an ordinary wall scraper. At this time the slime, which is composed of the softened cheese, whey, salt, and the microorganisms, is carefully removed. Care should be taken not to scrape the cheese too deep, for the surface at this period contains a high percentage of salt.

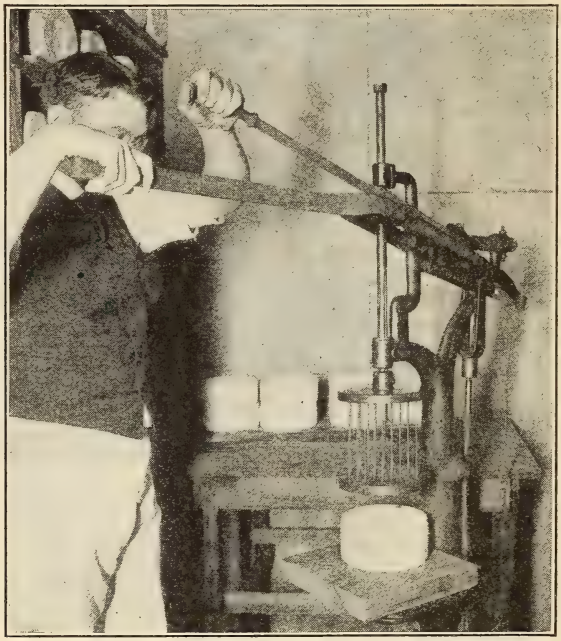

FIG. 6.—Each cheese is punched, or pierced with steel needles, to admit oxygen and aid the development of the mold.

In all this work at Grove City there was a loss of about 3½ per cent of cheese. Figuring on the basis of 4¾ pounds for the weight of each cheese, an examination of 1,040 cheeses showed a loss of 3.28 per cent. The losses in French cheese are somewhat higher.

Punching.—Punching follows the first scraping of the cheese, which takes place in from 10 days to 2 weeks from the time the cheese enters the curing room. Oxygen is necessary for the proper development of the mold, and in order to insure its entrance each cheese is pierced with a steel needle in from 20 to 60 places. An examination of three imported cheeses shows that they average 20 holes per cheese; domestic cheese made at Grove City is punched about 30

times. The needles are about 3 millimeters, or ⅛-inch in diameter. In France a specially constructed machine is used for this purpose and the cheeses may be punched at the rate of from 6 to 12 a minute. By the use of a remodeled drill press provided with steel needles, as shown in figure 6, one man can punch 50 or 60 cheeses an hour. Punching favors the mycelial growth and hastens the ripening. After being punched the cheeses are set on edge instead of on their flat surfaces, as has been the case heretofore. Placing the cheese in this position insures a maximum quantity of air in contact with the mold.

RIPENING THE CHEESE.

The temperature of the caves of Roquefort varies from 4° to 8° C. (39.2° to 46.4° F.). According to Marre, "the best caves are those where the temperature does not exceed 5° C. (41° F.) when the caves are empty, and 7° to 8° C. (44.6° to 46.6° F.) when the caves are filled with cheese. Unfortunately there are many caves in which the temperature is higher and reaches 10° to 12° C. (50° to 53.6° F.)."[12] The air of the rooms is cooled by evaporation caused by the air rushing through the channels with great intensity. In the winter the air change is not so rapid as in the summer; nevertheless the temperature in the caves remains practically the same the year round. According to their situation, number, and quality, the air channels in these caves have a greater or lesser value. Often these currents of air have a velocity of 5 meters a second. According to Saussure's hygrometer these rooms have a relative humidity of from 90° to 100°.[13]

The conditions which appear to be most ideal for curing cows'-milk Roquefort, in the experience at Grove City, are summarized as follows:

TABLE 10.—*Conditions favorable for curing Roquefort cheese.*

Period.	Temperature.	Relative humidity	Ventilation.
	Degrees F.	*Degrees.*	
First week	65–68	[1] 85–90	Slight.
Second week	48–50	80–90	Considerable.
Third and fourth weeks	48–50	[1] 80–90	Do.
Second and third months	46–48	90–95	Moderate.
Fourth and fifth months	46–48	[1] 80–90	Considerable.

[1] About.

The humidity and ventilation indicated here can not be expressed with any greater degree of exactness at the present time. They serve to show in a general way, however, the conditions that have proved most successful.

[12] Marre, E., Le Roquefort, p. 132.

[13] Marre, E., Le Roquefort, p. 134.

EQUIPMENT FOR CURING ROQUEFORT.

It has been found necessary to have well-insulated curing rooms and a special kind of conditioning apparatus to approximate the conditions in the cases of Roquefort. In the plant at Grove City, Pa., the sides, tops, and bottoms of the curing rooms have been insu-

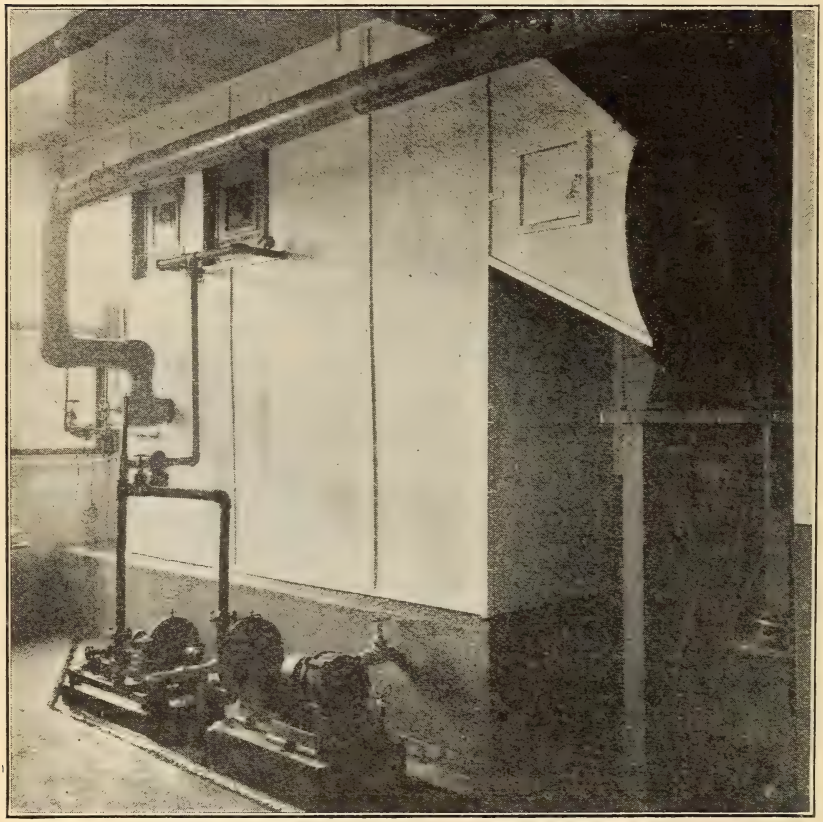

FIG. 7.—Refrigerating and conditioning apparatus used for maintaining the proper temperature and moisture conditions in curing and storing Roquefort.

lated with 4 inches of cork laid in hot asphalt and covered with Portland-cement plaster.

Conditioning equipment.—Several years of experience in the manufacture of mold-ripened cheese has proved the inefficiency of the ordinary means of controlling the humidity. No great difficulty has been experienced in adjusting the temperature to the desired point by the use of proper refrigeration. Attempts to hold the temperature as low as is necessary with Roquefort and still maintain a high humidity meet with more difficulty. Cooling Roquefort curing rooms by means of direct-expansion or brine coils has not proved successful. With such a system moisture is continually removed

from the cheese, and as a consequence it becomes too dry. Cheese handled in this manner ripens slowly, surface molds fail to develop, and the flavor is impaired. If much humidity is used the refrigerating coils become coated with ice and frost and the efficiency of the refrigerating system is greatly reduced.

Air conditioning.—Air conditioning has been used in other industries to regulate artificially the atmospheric conditions of a room or building and maintain and regulate certain desirable and definite conditions of humidity, temperature, and air purity. So far as is shown by the literature, no one has adopted this method of conditioning the air for curing cheese. It is not only desirable to regulate cheese-curing conditions, but to prevent the mold from one curing room from mixing with the air of another and thereby causing trouble There is little danger of such condition causing trouble with Roquefort. It is quite possible, however, that the air from a Roquefort room may contaminate the air in a Camembert room.

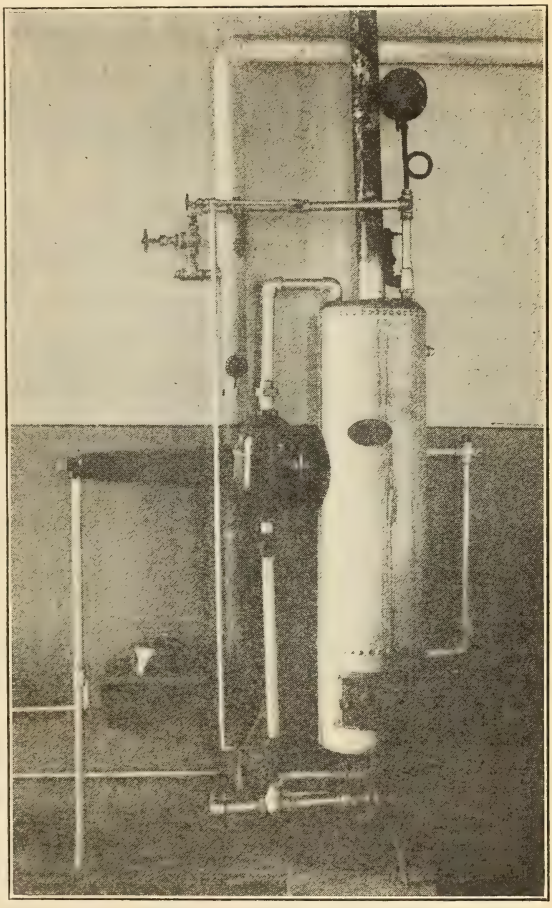

FIG. 8.—Apparatus for maintaining a constant humidity.

The system for regulating the temperature and humidity used in the curing rooms at Grove City includes an air washer with a fan for circulating the cooled air in a closed circuit throughout the rooms. The air washer consists of a series of sprays through which the air is drawn on its return from the rooms. The washer is so arranged that the water for the sprays flows over direct-expansion ammonia coils, which cool it to about 32° F. Below the coils is a storage tank from which the water is forced through the

sprays by a rotary pump. Between the sprays and the fan is a series of baffle plates to remove the entrained water. Insulated ducts carry the air into the curing rooms through the ceilings. Two inlets are provided for a room 11 by 19 feet. The temperature of the room is held constant by dampers in the inlets, operated by compressed-air motors. These motors are regulated by a thermostat. Four outlets in the ceiling of each room connect with a common duct, which returns the air to the washer. This system insures a thorough circulation of air within the room. By this arrangement the air leaves the air washer at a temperature of 40° to 45° F. and in a saturated condition. As it mixes with the warmer air of the curing room the relative humidity drops, and it is necessary in some cases to bring it to the desired point by introducing additional moisture. This is done very satisfactorily by blowing a jet of steam into the current of air as it comes into the room. This steam is carried under very low pressure and may be regulated by hand so that the relative humidity is held within narrow limits. The steam is at once absorbed by the air, and while it adds a small amount of heat it has given very satisfactory results.

PHENOMENA OF RIPENING.

During the first weeks there is a gradual development of a reddish slime upon the surface of the cheese, interspersed with patches of white and green mold. The latter in most cases is the Roquefort mold. Judging from descriptions, domestic Roquefort does not take on the same vigorous development of the white mold as occurs with the French cheese. Sometimes the slime fails to develop rapidly. By using some of the scrapings from imported cheese and sprinkling the domestic cheese with a mixture of these scrapings and water the development of this mold growth may be brought about without great difficulty.

After the first scraping there is only a slight development of the white and green mold, but there is a much greater development of the slime organism. The growth needs to be removed every few weeks in order to permit the air to reach the mold in the interior of the cheese. The development of the mold and slime is sufficient to destroy the acidity of the cheese, and the removal of this growth is necessary to prevent a putrefactive fermentation. Like the mold on the outside, the mold on the inside does not appear to develop to any marked extent after the first scraping. When held before an electric light, if the cheese is cured at a temperature of from 48° to 50° F., the hyphæ of the mold may usually be seen through the punch holes in less than 10 days after punching.

Within two or three weeks the colored mold is often well developed, and within a month there is very likely to be as much colored

mold visible as when the cheese is cut, several months later. The mold in the center of the cheese appears to develop more rapidly than that nearer the surface, possibly because of a less high concentration of salt. In the earlier stages of ripening, the flavor of the cheese often appears bitter to the taste. Later this condition disappears and a sweet, piquant flavor is noticeable, with little or no suggestion of bitterness.

Under the proper conditions the texture of the cheese can be made to approximate closely that of an imported cheese. The typical peppery flavor is found in some cheese, while in other cheese it is quite lacking. Sometimes there is an overdevelopment of sharpness in the flavor and the cheese becomes repellent to the taste. This is said to be due to an intense oxidation, as is evidenced by the formation of formic acid.[14] When the cheese is held at too high a temperature for a long period this condition may result in a cheese that is too piquant.

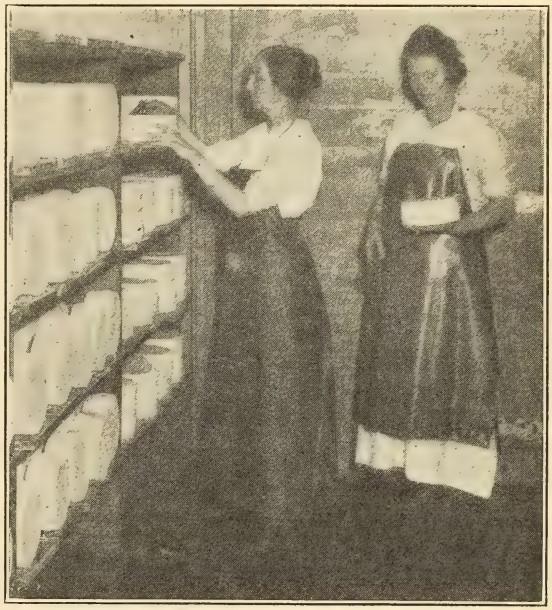

FIG. 9.—Scraping the cheese allows the air to reach the inside and permits the proper development of the mold.

At the time of ripening, Roquefort cheese should contain from 40 to 42 per cent water. This should be reduced to from 38 to 40 per cent by the time the cheese is put into the foil. A high humidity prevents the cheese from drying out. Dryness causes a cheese to ripen slowly; the texture becomes too waxy and the typical flavor is lacking. Moist conditions increase the rapidity of growth of the bacteria and mold on the surface. Despite much investigation, there are no experimental data to show that the surface growth aids in ripening the cheese, yet its presence is always associated with the best grades of cheese. The function of the slime appears to be to check the surface mold and aid in keeping the cheese in a sweet and normal condition.

[14] Lebrou, P., Les applications du froid en Aveyron à la préparation des fromages de Roquefort. In 2d Intern. Cong. Refrigeration Industries, Vienna, 1910, p. 428.

Occasionally the mold and flavor fail to develop, in which case the cheeses are repierced and again exposed to the free air of the curing rooms. At the time of enveloping in foil there should be an abundance of mold and some flavor; however, the flavor appears flatter and less pronounced than after the cheese has been left in the foil for a few months. Whenever cheeses are repierced care must be taken to maintain a high humidity and low temperature, or they will become dry, friable, the mold will take on a dark color, the flavor will be sharp and unpleasant, and the cheeses will be of poorer quality than before this operation. The cheeses should be wrapped in tin foil within two or three weeks after the second piercing.

In the preliminary work by the Bureau of Animal Industry it was often necessary to use a temperature of from 50° to 60° F. and under these conditions a great deal of difficulty was caused by the invasion of the surface slime into the punch holes. A high humidity and temperature result often in the invasion of the slime into the interior of the cheese, which not only causes a very unattractive appearance but impairs the flavor of the cheese. This serious difficulty has been partially, if not wholly, eliminated by the use of low temperatures, from 45° to 50° F. This is one reason why a low temperature for curing this cheese is desirable.

Ripening period.—Roquefort cheese from cows' milk requires from three to five months to ripen. The ripening period may be shortened by raising the moisture content of the cheese, but this will be at the expense of quality. By the use of refrigeration the cheese may be made when milk is abundant, and ripened and marketed in the winter, when it commands a higher price; in fact it may be made the year round. The imported cheeses are ripened in from one to three months and often they are sold directly from the curing shelves without preliminary ripening in the foil. With cows'-milk Roquefort it is often difficult to ripen the cheeses under three months, and a longer time is better. The best results have been obtained by ripening three months on the shelves and at least two months in the foil. It has so far not been possible to obtain cheese with the best flavor unless ripened in foil. When the foil-wrapped cheese has been ripened to the desired point, it will keep in good condition for from eight months to a year, provided it is held at a low temperature and is not too moist. Preferably the cheese should be held at a temperature of only a few degrees above 0° C. or 32° F. However, rather moist cheese has been kept from six to eight months in good condition at a temperature from 45° to 50° F. During this period the cheese did not deteriorate but rather tended to improve in quality and become sweeter and more fragrant. Cheese that is very moist may be ripened in a shorter period but it is not so easily

handled, losses are higher, and it is far more easily damaged in transit.

LOSSES IN CURING.

The losses of cheese by scraping, brushing, and handling are quite heavy. With Roquefort, special brushing equipment reduces both the losses and the cost of manufacture. According to reports on the industry in France a brushing machine can brush from 4,500 to 5,000 cheeses in an 8-hour day, and requires only two or three workers. With a knife a worker is able to scrape from 200 to 300 cheeses a day. It has been found in French practice that at each scraping, losses are reduced from 5 per cent where a knife is used to one-half of 1 per cent by the use of the brushing machine. Without special precautions with respect to refrigeration, depending on the perfection of ripening, salt content, and quality of the cheese, the losses run from 16 to 22 per cent. In France the first scraping is done by machinery. Scrapings at the ripening stage are made by hand. Normally the cheeses are exposed to the air in the caves from one to four months, and it is necessary to brush them every 10 or 15 days. In order to have a supply of cheese the year round, the imported cheese, which is manufactured only six or seven months in the year, is subjected to low temperatures of refrigeration and may be withdrawn according to the demands of the market. By this system the cheese is wrapped in foil and then subjected to a very low temperature. Later it is exposed to the air of the caves and ripened at a higher temperature. Often the cheese is held a year at a temperature just a little above 0° C. (32° F.). At this temperature practically all fermentations are checked. When again subjected to the air of the caves the cheese ripens with redoubled intensity and is more quickly broken down than when the other system is used and the cheese is not ripened in the foil. By the use of the holding system more delicate flavors are developed than when the cheese is ripened and shipped directly from the curing rooms. The practice just described reduced losses from 21 per cent to 9 per cent. These figures, which were given by Marre, are based on a comparison of approximately 869,000 pounds of cheese ripened without refrigeration and 1,001,000 pounds ripened with refrigeration.[15]

The domestic cheese is first ripened to a certain degree and put into the foil. The cheeses are scraped three times. There is a loss of 3.28 per cent in the first scraping, 2.12 per cent in the second, and 2.02 per cent in the third, making a total loss of 7.42 per cent. These figures were based on an arbitrary figure of $4\frac{3}{4}$ pounds as the average weight of each cheese. More than 1,000 cheeses were used in obtain-

[15] E. Marre, Le Roquefort, pp. 142-146.

ing the figures for each scraping. The loss in cows'-milk Roquefort seems to be somewhat less than that of sheep's-milk Roquefort. This may be due to a difference in the nature of the two milks or to a more vigorous development of the slime organism in the case of sheep's-milk cheese. At any rate the rather heavy losses that occur in the domestic and foreign cheeses indicate that these losses are normal and that probably this fermentation is rather to be encouraged than discouraged even though the losses may seem somewhat heavy.

USE OF TIN FOIL.

The function of the tin foil is to prevent desiccation, excessive oxidation, and the escape of the volatile substance from the cheese. After the last scraping the cheeses are wrapped in tin foil. There always seems to be an improvement in the quality of the cheeses wrapped in foil as compared with those not handled in this manner. Curing the cheese in the foil for a time appears to aid in the development of the sweet flavor and reduces to a minimum the strong, biting, and soapy flavors which may occur when the cheese is exposed too long to the action of the air. Because of the ripening changes going on within the cheese it has a slightly higher temperature than the surrounding air. The tendency of the moisture of the cheese to condense when covered with the foil and held at a low temperature must cause a circulation of the ripening agents. Here the foil acts as a condensing medium, prevents the escape of liquid and volatile substances, and the surface of the cheese tends to have the same homogeneous texture and composition.

The use of paraffin as a substitute for tin foil has not proved to be satisfactory. Unless the surface of the cheese is very dry the paraffin does not adhere readily in a coating of less than about $\frac{1}{8}$ inch. A normal cheese is entirely too soft for a thin layer of paraffin, such as might be used with Cheddar cheese. Because of the soft nature of the cheese and because the surface of the coating may readily be broken the paraffined cheese is sure to suffer from lack of protection from the dry air. When foil is used the cheese is better protected and may be wrapped more easily and securely with parchment paper.

While tin foil as a covering is more expensive than paraffin, it is more efficient and more attractive in appearance, so that the additional expense seems justifiable when the value of the product is considered.

Shrinkage.—The loss from shrinkage will vary, depending upon the moisture content of the cheese when enveloped in foil and the temperature and length of time held before shipment. With 16 cases of cheese held for a period of five months, at a temperature of from 45° to 50° F., there was an average loss in weight of 4.58 per cent. These cheeses were a little too moist when wrapped in foil.

Even under the best of conditions, however, there is some shrinkage, due largely to evaporation.

Yield.—Milk testing 4 per cent butterfat should yield from 10 to 11 pounds of cheese per 100 pounds of milk. These figures are based on the final weight of the cheese after curing and when ready to be shipped.

COST OF MANUFACTURE.

The figures given on cost of manufacture are based upon milk testing 3.8 per cent fat and costing $3.20 per 100 pounds. The daily costs of fuel, water, electricity, and depreciation are based on figures supplied by the engineer of the Dairy Division. The yield of the cheese was figured at 10½ pounds for each 100 pounds of 4 per cent milk. An average weight of 4¾ pounds per cheese was used in these figures. The labor was figured as one man to each 1,000 pounds of milk and the cost of labor at $75 a month. This did not include supervision of work; the figures were based on the use of one-third of the curing space in the factory and on one-third of the other operating expenses. It is estimated that 5,000 pounds of milk were made into cheese daily, based on 26 working days in each month. The foil was charged at $1.10 a pound and the shipping boxes at $0.52 each. Salt was charged at ¼ cent a pound. The following is the estimated cost of producing Roquefort cheese.

TABLE 11.—*Estimated cost of producing cows'-milk Roquefort cheese.*

Item.	Cost per pound.
Interest, repairs, and depreciation of insulation	$0.0047
Interest, repairs, and depreciation of refrigerating equipment	.0047
Cost of fuel	.0131
Cost of electricity	.0205
Interest, repairs, and depreciation of cheese equipment	.0058
Interest on money invested in building, insurance, taxes, repairs, and depreciation	.0443
Cost of water and steam	.0010
Cost of milk	.3047
Cost of labor in making cheese	.0220
Cost of labor in refrigeration	.0104
Interest on cheese and labor	.0085
Cost of foil	.0105
Cost of boxes	.0091
Cost of salt	.0002
Cost of rennet	.0001
Cost of wrapping paper and string	.0036
Total cost per pound	$0.4632

MARKETING METHODS.

Roquefort cheese is marketed in wooden boxes holding from 6 to 12 cheeses each. The inside dimensions of the 12-cheese boxes are 8 by 8 inches by 3¾ feet. The box is divided with boards into three compartments, and the material used is ⅜-inch pine, with ⅝-inch ends and dividing boards. The latter protect the cheese and give strength to the box. The foil should be wrapped neatly and securely

about the cheese. The dimensions of the foil are 22 by 13 inches, and it has a weight of 1 pound for 6,500 square inches. The foil is separated from the cheese by means of parchment paper to which it is attached. Ordinarily the trade name and design are printed in black upon the foil. When ready to ship, all cheeses are wrapped in strong, brown, wrapping paper, tied with a cord, and for convenience the net weight of the cheese is marked on the paper. Both paper and foil tend to hold the cheese in shape and protect it in transit. The wrapped cheese is then packed in sawdust, pine shavings, or excelsior, in order to absorb any leakage brought about by a change from low to high temperatures. No difficulty has been experienced from the cheese absorbing woody odors from the box or packing material.

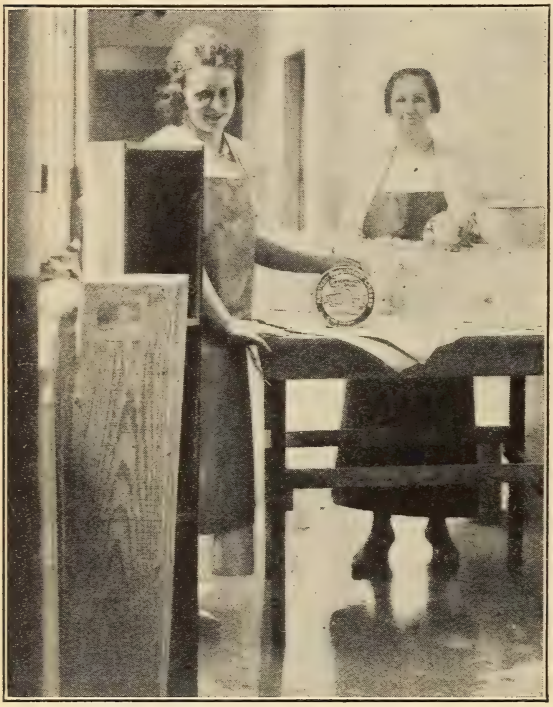

FIG. 10.—Packing Roquefort for shipment. The cheeses, wrapped in tin foil and wrapping paper and surrounded with sawdust, are packed 12 in a box.

The wholesale price received for the cheese has averaged 10 or 15 cents below that of the imported cheese. A natural prejudice, which is hard to overcome, exists against domestic cheese made from cows' milk. The cheese has been criticised most often for its yellow color and the lack of the characteristic piquancy of the imported cheese. It is probably impossible to produce on an average a cheese from cows' milk as white as that from sheep's milk. Some of the cheese made, however, has been above reproach in respect to both color and piquancy.

POSSIBILITIES FOR DOMESTIC ROQUEFORT.

The making of cows'-milk Roquefort on a commercial scale should not be attempted by inexperienced operators or where the equipment for proper curing conditions is lacking. In the past, efforts to make Roquefort on a factory scale have failed, largely because of the fact that these factors have not received proper consideration.

Undoubtedly a market can be developed for a cows'-milk Roquefort, but it will require advertising and a proper selling organization to break down the existing natural prejudice against a domestic cheese of this character. While the cheese, in most cases, can be distinguished from sheep's-milk cheese, it will require a connoisseur to make this distinction always, so closely does this cheese resemble the imported article in respect to flavor, texture, and color of mold. With only a limited commercial experience at present there is reason to believe that future work will tend to improve both the quality and the uniformity of the product and that eventually cows'-milk

FIG. 11.—Mold growth in cows'-milk Roquefort cheese made at Grove City, Pa.

Roquefort will become one of the established varieties of cheese made in the United States.

SUMMARY.

The Roquefort cheese from France is made of sheep's milk and is one of the oldest cheeses of which there is record. The average composition of good Roquefort cheese is about as follows:

	Per cent.
Water	38
Fat	32
Protein	20
Ash	6
Salt (NaCl)	4

Sheep's and cows' milks differ physically and chemically. The ratio of the fat to the protein is about the same in either case.

Fresh, clean milk is essential. Three or four per cent of a starter is used and the milk brought to an acidity of 20 to 23 before setting.

The milk is warmed to from 83° to 85° F. and set with rennet at the rate of 3 to 4 ounces per 1,000 pounds of milk.

The milk is allowed to set for from 1 to 1½ hours and the curd is then cut into small pieces with a ⅝-inch curd knife.

Ten minutes after cutting, the curd is scooped on to a draining rack and allowed to drain for about 20 minutes.

As the curd is placed in the forms it is sprinkled three or four times with the mold powder.

The cheese is turned three or four times the first day and at least twice a day thereafter until salted. The temperature of the drain room should be from 65° to 68° F., with a relative humidity of 85° to 90°.

The cheeses in the drain room are washed every day for four or five days, after which they are salted in a special room in which a temperature of 48° F. and a relative humidity of between 80° and 90° are maintained. The salting process requires a week or 10 days. A special conditioning apparatus is necessary to maintain the proper temperature, humidity, and ventilation. The cheeses are then pierced 30 or 40 times and placed on the shelves, where they rest on their edges instead of their flat sides as previously.

By means of refrigeration and a special conditioning apparatus the cheeses are ripened at a temperature of from 45° to 50° F. with very little ventilation. During the salting period and while the cheeses are wrapped in foil the air should be cold and dry.

The cheeses are ripened for two or three months; during this period they are scraped every three or four weeks, with an aggregate loss of from 7 to 8 per cent. After ripening, the cheeses are enveloped in foil and held for at least one or two additional months.

At Grove City, Pa., the estimated cost of making 1 pound of cows'-milk Roquefort was $0.46.

With 4 per cent milk the yield of cheese should be 10 or 11 pounds per 100 pounds of milk.

When cured the cheeses are wrapped in parchment-lined tin foil packed in excelsior, and shipped 12 in a box.

With proper curing conditions and experienced help cows'-milk Roquefort may be manufactured successfully.

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